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SHORT REPORT

Diagnostic Pitfalls in Atypical Coronary-subclavian Steal Syndrome

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We present a case of a 63-year-old patient with crescendo angina 12 years after coronary artery bypass graft surgery. Angiography demonstrated coronary-subclavian steal caused by severe left subclavian artery stenosis with collateral flow from an anomalous left vertebral artery, arising from the aorta. We discuss the unique angiographic features of this atypical case of coronary-subclavian steal syndrome along with its treatment.

Keywords: Coronary subclavian steal syndrome; Vertebral artery; Antegrade; Retrograde.

Introduction

Coronary-subclavian steal syndrome with anomalous origin of the left vertebral artery from the aortic arch comprises a unique set of clinical and angiographic findings, including myocardial ischemia without the associated 'classic' signs of vertebrobasilar ischemia.

We report a case of coronary-subclavian steal syndrome in a patient with severe global vasculopathy, severe unstable angina and an anterior ischemic defect on stress Thallium examination. In this case, however, the ipsilateral vertebral artery arose aberrantly from the aorta, proximal to the origin of the left subclavian artery and supplied collaterals to the occluded left subclavian artery by means of small cervical branches anastomosed to the thyrocervical trunk.

Case Report

A 62 year old male presented to our hospital with complaints of progressive exertional chest pain and angina at rest. His past medical history included hypertension, hyperlipidemia, emphysema, renal failure, and severe diffuse peripheral arterial disease. The patient had previously undergone coronary artery bypass graft surgery in 1991, with a left internal mammary artery graft to left anterior descending artery.

On presentation, the physical examination revealed blood pressures in the right and left arms of 124/58 and 88/56 mmHg, respectively. No carotid or supraclavicular bruits were auscultated. Cardiac examination was normal.

The brachial artery blood pressures in the right and left arms were 120 and 65 mmHg, respectively. The radial artery systolic blood pressures in the right and left arms were 120 and 65 mmHg, respectively. The left brachial and radial waveforms were biphasic and monophasic, respectively, with broadening and diminished upstroke. Carotid ultrasound exam was not performed.

Cardiac catheterization revealed a patent left internal mammary artery graft to mid left anterior descending artery, patent saphenous vein graft to diagonal artery with an eccentric 80% proximal stenosis, patent saphenous vein graft to obtuse marginal branches one and two with 90% stenosis in the proximal segment, and a totally occluded saphenous vein graft to right coronary artery. The right coronary artery filled via left to right collaterals. A subtotal occlusion of the proximal left subclavian artery was noted during left internal mammary artery angiography. The patient was then referred for left subclavian angiography.

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Aortic arch angiography was not performed, to conserve contrast in the setting of renal failure. Instead, selective left subclavian angiography confirmed a 95% stenosis in the proximal segment of the left subclavian artery (Fig. 1). Flow into the left vertebral artery was not seen on the second injection, the catheter slipped out of the subclavian artery and inadvertently engaged the left vertebral artery, which arose directly from the aortic arch (Fig. 2). Flow in the left vertebral artery was antegrade, with a 50% ostial stenosis of this vessel. The proximal left subclavian artery was reconstituted distal to the severe stenosis via retrograde collateral flow from branches of the left vertebral artery to the thyrocervical trunk.

After evaluating therapeutic options, a decision was made to proceed with percutaneous treatment of the subclavian stenosis. A seven French, 90 cm long sheath was positioned at the ostium of the left subclavian artery. The lesion was crossed with a 0.035 in. angled glidewire and pre-dilated with a 5.0×40 mm^2 balloon. A 6.0×29 mm^2 bare metal stent was deployed. This stent was post-dilated utilizing a 7.0×20 mm^2 balloon to 10 atmospheres (7.3 mm diameter) (Fig. 3). Final selective left subclavian angiography (Fig. 4) revealed excellent stent apposition with no residual stenosis in the proximal vessel and brisk antegrade left subclavian and left internal mammary artery flow. Flow was now antegrade in the thyrocervical trunk. Selective left vertebral artery injection (Fig. 5) now revealed only minimal competitive flow in the collateral branches anastomosed to the thyrocervical trunk.

The patient's subsequent clinical course was uneventful. He was discharged on aspirin and clopidogrel. His angina improved considerably, and he later returned for elective coronary angioplasty to preserve vein graft patency.

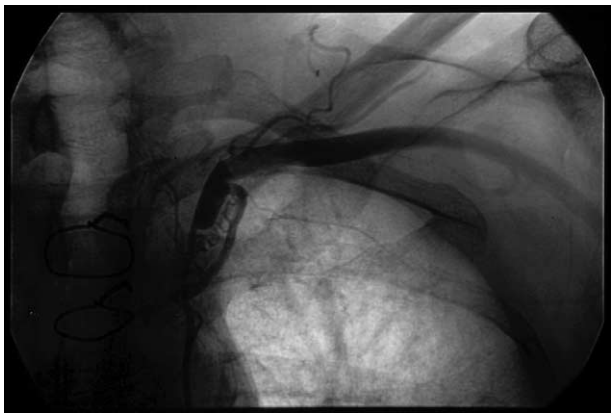

Fig. 1. Selective left subclavian arteriography prior to intervention reveals subtotal proximal left subclavian artery (LSCA) occlusion. Flow in the left internal mammary artery (LIMA) graft is antegrade but competitive. The left vertebral artery is not seen.

Discussion

In embryologic development, the vertebral arteries play an important role in anchoring the developing subclavian vessels during the descent of the aorta. The vertebral artery is formed by the serial longitudinal anastomosis of the upper seven dorsal segmental arteries. The vertebral artery becomes a branch of the subclavian trunk when the proximal portions of the upper six dorsal segmental vessels disappear. The artery then assumes is usual origin, arising from the upper, posterior surface of the subclavian artery, about 1.5–2 cm medial to the thyrocervical trunk. The vertebral arteries are the most constant of the subclavian branches in terms of their origin. Persistence of the proximal portion of the incorporated sixth dorsal segmental artery, however, allows the left vertebral artery to arise as a branch of the aortic arch, proximal to the origin of the left subclavian artery. Anomalous origin of the left vertebral artery from the aortic arch is relatively rare with a prevalence of 3–5% of cases in anatomic series.[1]

The subclavian steal syndrome, first described in 1966, involves a triad of findings: a proximal subclavian artery obstruction, reversed flow in the ipsilateral vertebral artery, and symptoms of cerebral ischemia.[2] The flow reversal usually occurs when there is at least a 20–40 Torr negative pressure gradient between the vertebral-basilar artery junction and the vertebral-subclavian artery junction.

The nomenclature was broadened in 1988 to include a coronary component, the so-called 'coronary-subclavian steal syndrome', to describe cases that involved diversion of blood from the myocardium through an internal mammary graft because of a proximal subclavian artery obstruction, with resultant myocardial ischemia. The incidence of this phenomenon has been reported to be up to 3% after coronary artery bypass surgery.[3]

Cases of ipsilateral subclavian steal in the context of an aberrant origin of the vertebral artery have been infrequently described. Holder *et al.* described five angiographically confirmed cases of steal syndrome in association with an aberrant vertebral artery origin with antegrade rather than retrograde flow in this vessel.[4] In all five cases, blood was carried to the ipsilateral subclavian artery by means of a collateral network between the vertebral artery and the thyrocervical trunk.

Review of the literature revealed just one reported

Fig. 2. Fortuitous selective left vertebral artery angiography demonstrates antegrade flow in the left vertebral artery with collateral flow to the thyrocervical trunk via small cervical branches. A 50% ostial lesion of the vertebral artery is present. The mid left subclavian artery is reconstituted beyond the proximal stenosis via retrograde flow from the thyrocervical trunk.

case of symptomatic coronary-subclavian steal syndrome in the setting of an aberrant vertebral artery origin.[5] In this case, as in ours, the left vertebral artery arose directly from the aortic arch proximal to the origin of the left subclavian vessel, and supplied collateral flow to the subclavian artery by means of small cervical branches anastomosed to the thyrocervical trunk distal to the occlusion.[5] As in our patient, the clinical syndrome in this case involved severe resting angina pectoris, clinical evidence of left arm hypoperfusion, evidence of myocardial ischemia in the territory of the patent LIMA graft, and no symptoms of vertebrobasilar insufficiency.

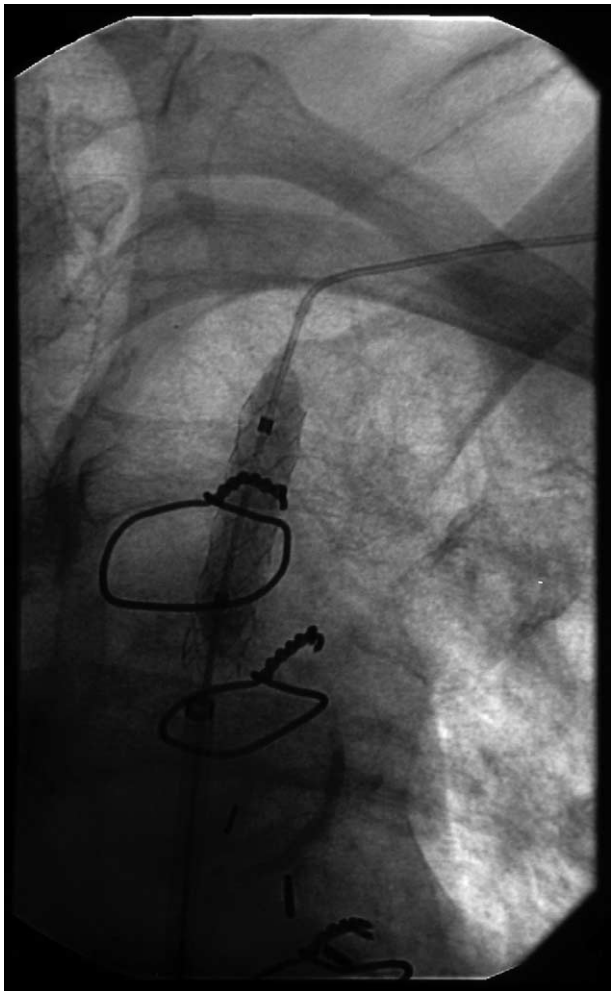

Fig. 3. Post-dilatation of bare metal stent in the proximal left subclavian artery.

Flow reversal in the ipsilateral vertebral artery has long been a diagnostic hallmark of the steal syndrome. Ozbek *et al.* demonstrated that flow reversal in the vertebral artery by Doppler imaging was a very sensitive and early indication of a proximal subclavian artery stenosis, even in cases of non-significant stenosis without related clinical symptoms.[6] Although not performed, the sole reliance on carotid/vertebral artery ultrasound in our patient would have likely missed the diagnosis entirely, in the absence of the ancillary testing and clinical exam that was performed. The limitations of sonography include difficulty in evaluating the proximal extra-osseous segment of the vertebral vessel at its origin. Similarly, selective left subclavian arteriography can also miss the anomaly. Poor opacification of the subclavian artery distal to the severe stenosis in this case lead to the false assumption that the vertebral artery arose at its presumed normal origin but was not visualized due to brisk retrograde

Fig. 4. Completion arteriography now reveals antegrade flow in the left subclavian artery with a widely patent proximal stent. There is antegrade flow in the left internal mammary artery graft and antegrade flow in the thyrocervical trunk.

Fig. 5. Selective left vertebral arteriography now demonstrates minimal competitive flow in the cervical anastomoses to the thyrocervical trunk after relief of the proximal left subclavian artery obstruction with stent supported angioplasty.

flow, as can be seen in cases of 'typical' subclavian steal syndrome. The aberrant vertebral artery may also be wrongly assumed to occluded or atretic, simply by lying outside the region of interest on MR or CT angiography.

Percutaneous angioplasty of the subclavian artery is the procedure of choice for the treatment of subclavian steal syndromes.[7,8] As this procedure gains widespread acceptance, the need for a careful evaluation of the cerebrovascular anatomy prior to planning an intervention becomes imperative. The acuity of presenting symptoms and the need to minimize the contrast load in this case, precluded a more detailed evaluation that may have alerted us to the presence of this particular vascular anomaly prior to angiography. In cases of selective brachial angiography in which there is non-visualization of the vertebral artery and evidence of antegrade flow in the vessel by some other diagnostic modality, an arch angiogram with careful selective catheterization of the head vessels may be necessary to exclude anomalies of origin of the vertebral artery from the aortic arch.

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